

CAUSES OF REINDEER (*RANGIFER TARANDUS*) AND MOOSE (*ALCES ALCES*) MORTALITY IN THE LAPLAND RESERVE AND ITS SURROUNDINGS

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ABSTRACT: The Lapland Biosphere Nature Reserve located above the Arctic Circle stretches across 2,780 km² of land on Russia's Kola Peninsula. Between the years 1930-1996, 206 moose ("elk" in Europe and Asia) (*Alces alces*) and 646 wild reindeer (*Rangifer tarandus*) deaths were recorded. Bears (*Ursus arctos*) were responsible for most of the moose and reindeer mortality: 68% and 30% of deaths, respectively. By comparison, wolves (*Canis lupus*) caused 8% of moose and 17% of reindeer deaths and wolverines (*Gulo gulo*) caused 1% of moose and 10% of reindeer deaths. In the area surrounding the Reserve, illegal hunting accounted for 6% of moose mortality and 18% of reindeer mortality, while road kills were responsible for 3% of all moose deaths and 1% of all reindeer deaths. In cases where hunters wounded reindeer outside of the Reserve their subsequent death inside the Reserve was recorded. Bears were of greatest danger to moose and reindeer in Laplandia; wolves tended to prey primarily on reindeer. Wolverine most frequently targeted weak or sick animals, though they have been known to occasionally attack adult moose. The mortality rate of adult males (both moose and reindeer) is consistently higher than the rate for females and calves. One explanation for this may be that calf remains are more difficult to discover and decay more rapidly than those of adults. Furthermore, as the remains of adult animals are more easily discovered than the remains of their young, it is possible that several deaths of young animals remained undiscovered. We were not able to discern the cause of 30% of moose deaths and 60% of reindeer deaths.

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The Lapland Reserve is in a region of the Russian Arctic represented by Northern-taiga mixed woods and mountain tundra located on the Kola Peninsula (67°40' - 68°15'N latitude and 31°07'-32°45'E longitude). The study of reindeer and moose since the establishment of the Lapland Reserve in 1930 has been given special attention in recognition of their importance in Lapland nature and ecology. Wild, hoofed animals seldom live to the end of their biological age limit and frequently perish from the harshness of their environment. The main causes of death of moose and reindeer in Laplandia are large predators such as bears and wolves. Since hunters

also pose a threat to their survival, the predators find themselves competing with man. This paper describes causes of death of moose and reindeer by season and sex and age of the ungulate populations from 1930 to 1996.

METHODS

The Lapland Reserve was closed between 1942 and 1945, and again from 1952 to 1957. Data from these periods are either non-existent or fragmentary. Some of our data have already been published: on moose for 1930-1947 (Semjonov-Tjan-Shansky 1948b), and on reindeer for 1930-1941 and for 1948-1973 (Semjonov-Tjan-Shansky

1948a, 1977).

Between 1930 and 1996, mortality of 206 moose and 646 reindeer was recorded in wintering areas (Fig. 1). Assessments were made mainly following the discovery

of remains at the site of death. Condition of remains vary greatly and usually fall into one of the following categories: (1) the entire or almost entire carcass; (2) remains of carcass eaten by predator; and (3) skel-

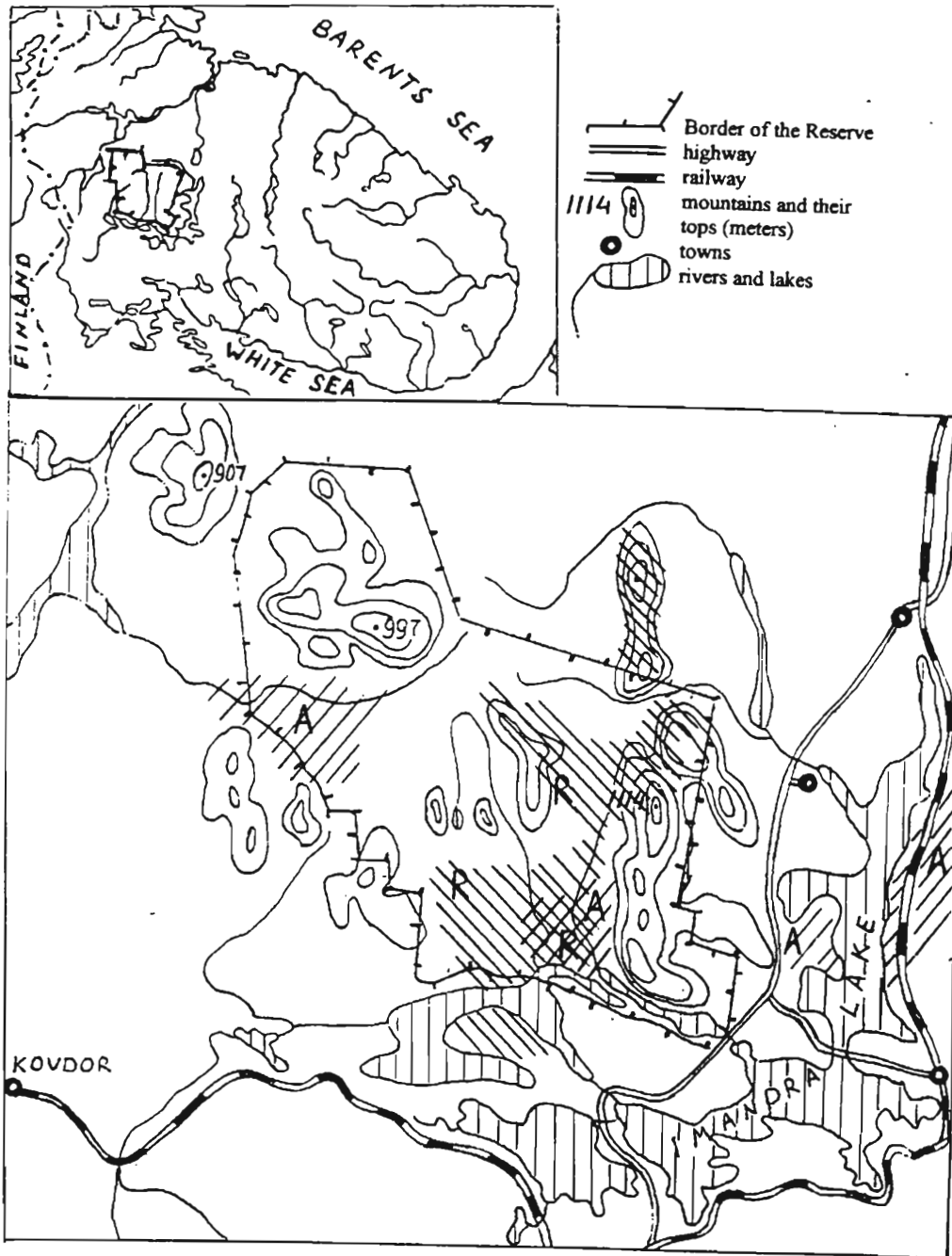


Fig. 1. Wintering areas of reindeer (\\) and moose (//), and general locations where dead reindeer (R) and moose (A) were found.

etal fragments >1 year old. Therefore, not all the necessary information for proper diagnosis was always present. To discern the cause and date of death, as well as the sex and age of an animal, we must often resort to indirect signs, such as the condition and texture of hair or fur and antlers, the content of the stomach, the size of the carcass, body fat content, etc. For example, it is possible to discern which predator killed an animal by considering the manner in which the carcass was treated. Bears always bury the carcass of their prey with branches, turf, or snow, and stay nearby until the prey is completely eaten. Many marks remain at the locations where bears have kept their prey. Wolves never protect or bury their prey. They may even leave it behind not fully eaten. Wolverines tend to drag and hide their prey. The origin of skeletal fragments and scraps of pelt displaced by wolverines are most difficult to diagnose.

Included in these data are some animals from the Reserve which died while outside of the Reserve's territory. These were mainly cases of poaching and road accidents. In rare instances, there were other causes of mortality.

RESULTS AND DISCUSSION

Data concerning the causes and timing of moose and reindeer mortality are presented in Tables 1 and 2 respectively. Of 206 known cases of moose and 646 reindeer deaths, causes were determined in 143 (69%) and 261 (40%) cases, respectively. The data on moose have been separated into 3 approximately equal periods of years, as their population has been more stable than that of reindeer. There are on average 6-10 moose per 100 km², with the highest numbers recorded in the 1930's and gradually diminishing through to the 1990's.

The living conditions for moose worsened with the increase of the human popu-

lation surrounding the Reserve. In addition to poaching, construction of the roadways interfered directly with the spring and fall migrations of moose wintering in the Reserve's pine forests.

The industrial exploitation of the Kola peninsula also had a negative effect on the reindeer population. The area available for suitable habitation has been sharply reduced over the years due to several factors, and migratory paths have been partially disrupted. The fluctuations of reindeer populations have been more frequent and larger than moose populations within the Reserve. The population of moose on the Reserve in winter never exceeded 300, while the population of reindeer has ranged from 100 to 13,000. As a result, the data for reindeer have been separated into a greater number of categories. From 1930-1941, the population of reindeer was very low; winterings occurred on the Reserve and the total population grew from 100 to 1,000. From 1948-1963, the total population continued to rise from 210 to 6,000 (after a decrease in 1942-45). From 1964-1968 reindeer reached their highest numbers; between 7,500 and 13,000 and the majority of winterings occurred outside of the Reserve. From 1969-1973 the population stabilized, but with a decrease from 13,000 to 9,000 reindeer; most wintering still occurred outside the Reserve. From 1974-1981 numbers fell sharply to a mere 150; reindeer again began to winter on the Reserve. From 1981-1996 the population rose once again to approximately 1,000; for the most part, winterings occurred inside the Reserve.

The first decrease noted between 1943 and 1945 was due to the large-scale shooting of reindeer during World War II. The second decrease in the 1970's was due to significant deterioration of the winter moss pastures.

Bears were the main threat to both moose and reindeer (Tables 1 and 2). Sixty-

Table 1. Deaths of moose (*Alces alces*) in the Lapland Reserve, Kola Peninsula, Russia, 1930-1996.

Index	1930-1947		1958-1975		1976-1996		Total	
	n	%	n	%	n	%	n	%
Size of sample	19		113		74		206	
Season								
winter (Nov.-Apr.)	-	-	32	30	15	22+	47	24
spring (May-June)	14	74	25	23	23	34+	62	32
summer (July-Aug.)	4	21	31	30	23	34+	58	30
autumn (Sept.-Oct.)	1	5	19	17	6	9	26	14
unknown	-	-	6	-	7	-	13	-
Structure of sample								
male adult	4	33	28	46	15	33	47	40
female adult	2	17	5	8	13	29	20	17
adult (sex unknown)	5	-	52	-	27	-	84	-
calves < 1 year	6	50	14	23	17	38	37	31
calf age unknown	2	-	-	-	-	-	2	-
calves < 1 month	-	-	14	23	-	-	14	12
data not available	-	-	-	-	2	-	2	-
Causes of death								
wolf	-	-	-	-	12	19	12	8+
wild dog	-	-	-	-	1	2	1	1
bear	19	-	41	66	35	56	95	66
wolverine	-	-	1	1+	1	2	2	1+
poaching	-	-	1	1+	8	13	9	6
illness, old age	-	-	5	8	1	2	6	4
drowning	-	-		11	18	-	11	8
related to the mating season	-	-		2	3	-	2	1+
road kills	-	-	1	1+	4	6	5	3+
reason unknown	-	-	51	-	12	-	63	-

six percent of all moose remains and 30% of reindeer remains discovered on the Reserve's territory were the result of bear attacks. After bears, wolves were the second leading cause of mortality for both moose and reindeer. Wolverine killed few moose but more reindeer (Tables 1 and 2). Wolverine tended to prey on disadvantaged animals, and only in rare cases were known to successfully attack healthy animals. These figures suggest that young moose and weak or sick adult moose are the easiest prey for wolves. In Karelia (1,000 km South of the Lapland Reserve) causes of

moose mortality are due to the following factors: poaching 23.9%; drowning 21.9%; wolf attacks 18.7%; and bear attacks 7.9% (Danilov *et al.* 1979). Causes of reindeer mortality are: predators (wolf, wolverine, lynx, bear) 33%; unknown 39%; ill and traumatized (including by transport) 28% (Lindgren *et al.* 1989).

Bear attacks on moose occur mainly in the early spring when the snow cover is still deep. Later in the year, bears tend to prey on younger moose, and by the fall, during the mating season, bears also prey on careless bulls. Bears begin hibernation on ap-

Table 2. Deaths of reindeer (*Rangifer tarandus*) in the Lapland Reserve, Kola Peninsula, Russia, 1930-1996.

Index	1930-1941		1948-1963		1964-1968		1969-1973		1974-1981		1982-1996		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Size of sample	16	100	69	100	146	100	191	100	196	100	28	100	646	100
Season														
winter (Nov.-Apr.)	16	-	36	68	71	52	80	53	110	57	8	29	321	55
spring (May-June)	-	-	3	6	37	27	49	32	30	16	3	11	122	21
summer (July-Aug.)	-	-	4	7	16	12	12	8	40	21	10	35	82	14
autumn (Sept.-Oct.)	-	-	10	19	12	9	11	7	16	7	7	25	56	10
unknown	-	-	16	-	10	-	39	-	-	-	-	-	65	-
Structure of sample														
male adult	11	85	15	42	40	42	44	38	23	33	8	53	141	37
female adult	2	15	12	33	9	10	21	18	28	40	4	27	76	20
adult (sex unknown)	3	-	4	-	6	-	2	-	109	-	13	-	137	-
calves < 1 year	-	-	9	22	28	26	27	23	16	23	2	13	82	22
calf age unknown	-	-	27	-	31	-	56	-	17	-	-	-	131	-
calves < 1 month	-	-	2	3	32	22	41	21	3	4	1	7	79	21
Causes of death														
wolf	16	100	1	4	3	10	-	-	15	11	9	50	44	17
wild dog	-	-	-	-	4	13	5	13	3	2	-	-	12	5
bear	-	-	3	12	9	30	14	37	47	35	4	22	77	30
wolverine	-	-	7	28	2	7	4	10+	9	7	3	17	25	10
poaching	-	-	8	32	5	17	4	10+	30	22	-	-	47	18
illness, old age	-	-	6	24	7	23	11	29	23	17	1	5+	48	18
drowning	-	-	-	-	-	-	-	-	2	1+	1	5+	3	1
bird of prey	-	-	-	-	-	-	-	-	2	1+	-	-	2	<1
related to the														
mating season	-	-	-	-	-	-	-	-	2	1+	-	-	2	<1
road kills	-	-	-	-	-	-	-	-	1	1	-	-	1	<1
reason unknown	-	-	44	-	116	-	153	-	62	-	10	-	385	-

proximately October 28th (based on unpublished statistics regarding last visible tracks, averaged over 49 years) and leave their dens on or about April 23rd (based on statistics averaged over 59 years). Bears are most active in the half of the year with the least amount of snow cover.

In absolute numbers, 95 moose and 77 reindeer were found that had been killed by bears, while their average population size over the study period has been approximately 150 and 1,500, respectively. Considering that an average of 22 bears are al-

ways present on the Reserve (their numbers vary between 12 and 32), roughly 7 moose and 70 reindeer are potential prey for each bear annually. Thus, moose are 12 times more likely than are reindeer to be killed by a bear. There are 2 possible explanations for this: bears tend to hunt during periods of frozen snow crusts through which moose can easily fall and get trapped. In addition, bears often hunt in the forest or on the banks of rivers and lakes, where they can easily conceal themselves while stalking moose. Reindeer are more difficult for

bears to attack since they have the same weight distribution as bears do on the snow surface and reindeer prefer open, less forested spaces where bears cannot easily conceal themselves before an attack.

Wolves are naturally better adapted to hunting reindeer than are bears, not only because of their tendency to hunt in packs, but also because of their speed and other factors. Nevertheless, bears, which hibernate for half of the year, on average kill more reindeer than do wolves (77 versus 44), which hunt year-round. This apparent incongruity is explained by the large bear population relative to the wolf population. It should be noted that the number of wolves on the Reserve ranged between 1 and 4 per year, and in the period between 1930 and 1938 they were not present at all. Wolves were first discovered in the area in 1939, when the number of reindeer had reached 800. Wolves regularly leave the Reserve while chasing reindeer, and many are then killed by humans. In the last 10-15 years, however, wolves have attacked reindeer more often (Table 2). This probably indicates that either the number of resident wolves has been rising or more wolves are being drawn onto the Reserve, where reindeer are more plentiful and where they have less chance of being targeted by hunters. The close predator-prey relationship between wolves and reindeer is further corroborated by the fact that the first time moose were found to have been attacked by wolves was in the years following 1981 when reindeer were at their lowest numbers. Unable to find their regular prey, wolves may thus have been forced to feed on moose. During the 1970's in the forest part of Russia, with the increase of moose numbers, wolves learned to prey upon moose more successfully and more often (Neganov 1977, Glushkov 1979, Pulliainen 1979, Bologov 1981). During the 1980's and 90's in the forest zone wolves are the main

(after man) predator of moose (Danilkin 1997) and reindeer (Druri 1949, Bergerud 1979, Davis *et al.* 1979, Syiroechkovsky, 1986).

Three to 5 pairs of wolverine and not more than 6 young (this year) individuals live in the Reserve and its surrounding area. Wolverine in contrast to bears and wolves, in almost all instances, satisfy themselves with sick, wounded, or old animals. The same occurrence pattern was observed in Pechora (Northeastern Europe) (Teplov 1955), Yakutia (Siberia) (Egorov 1971), Alaska (Rausch and Pearson 1972, Megun 1996), Karelia and the Leningrad region (Timopheeva 1974), and in Scandinavia (Haglund 1966). The frequently held speculation that wolverine eat newborn calves has not been supported by our observations. Wolverine, whose average weight is 11-16 kg and whose relatively low running speed is compensated for by great endurance, tend not to be active predators. They are important carrion-eaters of hoofed animals such as reindeer and moose.

In the years when the highest number of reindeer were recorded, there were cases of attacks by wild dogs. One case in particular was noted when a moose was savagely attacked in April by 3 dogs on frozen snow-crust.

Predated reindeer and moose follow a similar pattern in terms of their age and sex. All data are shown in Tables 1 and 2, except those cases in which the sex and age were indiscernible. If such cases were to be included in the calculations, the numbers would be higher, but would retain the same overall relative pattern (Table 3).

The high prevalence of males in the sample is probably explained by their tendency to become careless during the mating period, by the more rapid loss of fat reserves, and by their increased fatigue towards the end of each winter, particularly when snow is deep. In the Pechora taiga



cow moose are infrequently preyed upon by bear (Jazan 1972). The small number of new-born moose (<1 month) in the sample possibly is due to the fact that bears tend to eat them completely, and their remains are much harder to find in the woods than those of young reindeer in the tundra or forest-tundra. The arbitrary and inexact nature of discovering animal remains on the Reserve unquestionably affects the overall data. For example, the number of predatory acts can be exaggerated when a sick, dying, old, or traumatized animal is eaten by a predator. If their remains are found it will be calculated as a predatory act. Predators may also eat an animal which has died of natural causes, and this too will be noted as a predatory act.

According to our data, not less than 40% of all reindeer deaths and 22% of all moose deaths are perpetrated not by their natural predators, but by other factors, namely, poaching, illness, and physical trauma such as drowning, etc. (Tables 1 and 2). Included in the row entitled "Poaching" are cases in which reindeer were wounded by local authorities attempting to control over-population (as occurred during the population crisis of the early 1970's), returned to the Reserve, wounded and weak, and subsequently succumbed to predators or simply died of their wounds.

Moose and reindeer deaths due to infectious and parasitic diseases are known both in Northern Eurasia and in Northern America (Philonov 1983, Syroechkovsky 1986). We know of only 2 mortality cases of adult male reindeer because of *Bacterium*

necrophorum - both were very emaciated. The first one, a wild reindeer, died in February 1959; the second one (domesticated) died in April 1997. An outward symptom of this disease is lameness, and lame reindeer are frequently found in a herd. During early 1971 in the settlement of Krasnoshelye (eastern part of Kola Peninsula) several dozen domestic reindeer died due to infection by the nematode *Elaphostrongylus rangiferi*. In 1951-54 this disease was also observed among domestic reindeer driven from the Kola Peninsula to Karelia. Only calves were ill, usually in January and February. Since their hind extremities were paralyzed, they were not able to graze and died (Segal 1962, Semjonov-Tjan-Shansky 1977).

Analysis of numerous publications on this problem shows approximately the same structure and ratio of causes of moose and reindeer deaths in Northern Eurasia and America in similar habitats. Differences in data are caused by dimensions of different human pressure, ratio of species and numbers of predators and their prey, availability of alternative food, and weather conditions (Semjonov-Tjan-Shansky 1948a,b,1977; Teplov 1948; Kozhuhov 1965; Jazan 1972; Banfield 1974; Timopheeva 1974; Danilov *et al.* 1979; Pulliainen 1979; Vereshagin and Rusakov 1979; Philonov 1983).

In summary, the Lapland Reserve has an original combination of different factors demonstrating that bears are more important predators of both moose and reindeer in the Reserve; wolves prey primarily on rein-

Table 3. Sex and age structure of moose (*Alces alces*) and reindeer (*Rangifer tarandus*) found dead in the Lapland Reserve, Kola Peninsula, Russia, 1930-1996.

Species	Calves less than 1 month	Calves 2-12 months of age	Females, adult	Males, adult
Moose	7	18	22	53
Reindeer	22	23	19	37

deer but can successfully switch over to moose; wolverine eat more weak moose and reindeer, carrion and remains of wolf and bear - killed animals; deaths caused by infectious and parasitic disease are minimal; the mortality rate for adult moose and reindeer males due to predators is consistently higher than for females.

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